The role of openings in the Balai Padang House in Loksado, South Kalimantan

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Abstract

Balai Padang is one of the traditional architecture in Indonesia. The current Balai Padang traditional house has been surrounded by density of buildings with narrow spacing. The narrow distance affects the ventilation in the building. Results from field observation and measurements show generally very low wind velocity indoors.

Keywords: opening, traditional house, wind velocity

INTRODUCTION

Mechanical cooling using the Air Conditioning (AC) system is one of the largest energy use in buildings. More over if the building type was unsuitable with its microclimate and wasn't carefully designed for using mechanical cooling. The air conditioning system will only be short-term solution to fulfill human comfort. At the same time, mechanical air conditioning system demand higher energy use, produce heat to environment, and raise people dependency on mechanical system to achieve comfort.

For a long time in Indonesia, natural ventilation had been adopted in traditional architecture as response to local climate. This concept is environmental friendly, because it do not need electricity and have zero emission. Balai padang is one of tradisional house which is using natural ventilation. Balai Padang used as dwelling and place to held annual ceremonies.

Mechanical cooling system is now widely used, indicate that as technology, environment, and people evolve, modern building tends to abandon traditional values/concepts. Higher demand of energy that is limited, especially in Indonesia, create an important necessity to conserve and lower energy use by traditional concepts of passive and responsive architecture.

By context of traditional house (before 1982), Balai Padang was a single building surrounded by trees. Therefore, Balai Padang had no openings as to adapt to the cold outside environment. The expansion of development affects the density changes of the external environment around Balai Padang. This causes a change of the building façade. At this time, the traditional house was surrounded by other building density. As respond to the changing environment and local climate, Balai Padang adapt the design elements on the façade that is the presence of openings, this can be seen in Figure 1.

Several studies related to natural ventilation have done by Defiana (2012), describes the effect of distance between the buildings to the acquisition of wind inside the building. Febrita (2011) and Sukawi (2013), focused their research on roof ventilation as a passive cooling. Wahyudi (2013), his research related to the presence of openings as passive cooling for energy conservation in Sundanese traditional house.

This paper presents the performance of natural ventilation in Balai Padang custom building that have undergone changes in external environment. Those changes were signified by changes in design elements, namely the existence of openings due to changes in the density of the outdoor environment.

Fig. 1.The traditional Balai Padang and its modification now

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METHOD

The method used is descriptive method. Data obtained through field measurements for 24 hours. Measurements carried out outside and inside the building. On the outside of the building, measurement done in a single point using a weather station, which is placed in the middle of outer space. Indoor measurement is done by selecting the representatives of each side of the house. The room of the custom house Balai Padang, totaling 7 rooms, 6 of which is the bedroom that had a kitchen and living room while the other one is a dike which serves as a yearly ceremony. The measurements were performed at 4 rooms. Three of them are Bedroom and the other is Pematang. The selected room is Bilik1 (East), Bilik 3 (South) and the Bilik 5 (West). Measurements of the rooms using Kanomax anemometer. Grid measurements were made within 1-3 metres depend of dimension of room.

Table 1. Point of measurement in building

Zone	Point of measuring
Bilik 1	9 point
Bilik 3	4point
Bilik 5	4point
Pematang	9point

RESULT

Description Balai Padang

Balai Padang is one of the traditional houses in Indonesia, located in Meratus, Dayak Bukit Malinau, sub-district Loksado-South Kalimantan. Balai Padang geographically situated between 2 ° 29 '59 "-2 ° 56'10" latitude and 114 ° 51' 19 "-115 ° 36'19" east longitude. Balai Padang is placed on a plateau with an altitude 450 mdpl.

Balai Padang orientation is North-South. East and West side of the building are side by side with other buildings with a distance of 2 metres each side. North side is adjacent by the highway and buildings while South side is adjacent by packed trees.

The traditional house Balai Padang is a one-story house with the *panggung* construction. Column as foundation and building's support used local wood. The flooring use wood board which mounted tightly with no gaps. The wall is a wooden frame, while the East side of the wall is covered with woden cane, and the other three sides covered in wooden planks. The roof construction use wooden structure that covered by roof planks. There is no ceiling so the roof truss can be seen clearly from inside. There are no openings on the roof that could be functioned as wind/air circulation.

One that makes Balai Padang house unique was its kind of rooms inside. Rooms in Balai Padang were generally divided into three namely Pematang, Laras and Bilik (see figure 2).

Pematang is a room used for traditional ceremonies every year. The room is located in the middle of the house. *Pematang* has lower floor about 20 cm from other room. In the middle of the room there is a table used for ceremonies. On the table there were kind of unique ornaments, which nearly reached the roof of the house. Those will affect the air flow distribution, as can be prevent wind flow in the Bilik 3 (figure 3).

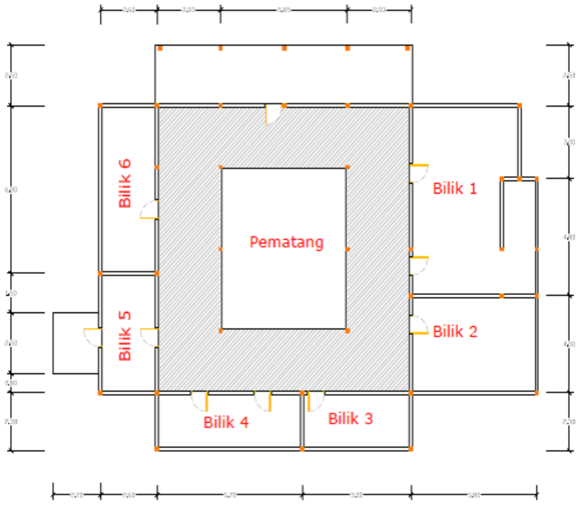

Fig. 2 Balai Padang Layout

Fig 3 Unique ornament for traditional ceremony in the middle of Pematang

Fig.4 Apperture in Balai Padang

Balai Padang openings is permanent (no shutters) (figure 4), so that the aperture is open for 24 hours. The top opening consists of triangle-shaped opening (as a result of the meeting between the roof and the walls in triangle shape following the shape of the roof) and square openings on the facade.

Wind velocity and direction and airflow distribution indoor

The measurements show that the dominant direction of the wind comes from West and East. The highest wind velocity outside the building, occurred at 12.00 which ranges from 0.4-2.2m/s. In each room has a different wind velocity. In Bilik 1, the highest wind velocity at 16.00 with a value of 0.54m/s, while the lowest wind velocity at 06.00 with avalue of 0.02m / s.

In Bilik 3, the lowest wind velocity was on all point at 02.00 with a value of 0.03 m/s, while the value of the highest wind velocity is at 12.00 with a value of 0.23m/s. In Bilik 5 lowest values are at 06.00 and 08.00, while the highest value are at 04.00 with a value of 0.49m/s.

Based on field measurement, the value of the wind velocity in the rooms shows that the distribution of the airflow in the room is uneven. The highest wind velocity value is on the nearest point to the opening and perpendicular to the direction of the windward. Distribution of airflow is uneven causing some point in each room has low value so it affects the comfort level of occupants in these spaces.

The tendency of uncomfortable conditions occurred at 12.00 to 20.00, in every room in the house. This was influenced by the direction and wind velocity that occurred outside the building. Based on field observations, the dominant windward direction comes from the West and the East, while in this direction the distance between buildings is narrow, causing flow resistance (the flow tends to be obstructed to entry) due to a short distance.

DISCUSSION

The influence of Window to wall ratio on wind velocity

Size of the opening affects the acquisition of wind into buildings. Based on Table 1, the dimension of inlet in *Bilik* 1, 3 and *Pematang* are smaller than outlet, it affects the wind pressure. When the inlet is smaller than the outlet, the wind pressure through the inlet becomes high, so that the value of the airflow velocity that perpendicular to the direction of the wind will be of great value. It causes the difference between the value of the airflow velocity in the room to be high, and make uneven distribution of wind flow.

While in *Bilik* 5 the outlet dimension is smaller than inlet, it affects the value of wind velocity tend to be uneven, because the pressure of short distance (Bloken, 2007)

Table 2.Window to wall ratio

Zone	A inlet(m2)	A outlet(m2)	A Wall(m2)	WWR (%)
Bilik 1	2.892	9.19185	69.912	17.28
Bilik 3	2.225	7.425	48.585	16.36
Bilik 5	5.485	4.785	51.558	19.9
Pematang	9.36	40.14	154.44	32.0

Air passed through the inlet is slower, so that the airflow spread to the points which are not only perpendicular to the direction of the windward but also at points that are on its side. Suitable size openings for cross ventilation is that the inlet size equal to the size of the outlet (Allard, 1998).

The Influence of position opening on wind velocity

Suitable height position for openings are the same height as occupant's activity ±50-100cm (Mediastika, 2002). Opening's position at the dining room should be as high as occupants when they sitting, as well as during sleep should be positioned as high as they sleep (Allard, 1998).

Based on table 3 the opening height position exceeds the height of the occupants, where the average height of the standing occupant was 150-170cm, the lowest part of the opening is at height of 170 cm, so the airflow is only about the occupant's head. That condition does not provide a cooling effect on the occupant's body. This happen due to the existing openings placed at the very top end wall that meets the roof.

Table 3.Opening position

Zone	Apperture internal height (cm)	Apperture external height (cm)	Wall Height (cm)
Bilik 1	200	180	250
Bilik 3	200	180	200
Bilik 5	200	170	200
Pematang	200	170	330

In *Bilik 1* which used as bedroom, there is a height difference that exist in the outer and inner wall, which is 180-250 cm from the floor. The opening on the East side of *Bilik 1* (which functioned as a kitchen) is 100 cm tall. As for bedroom, the height of the opening position is not as required, so that the airflow entered the room was not through the sleeping height. In the kitchen, the height of the openings are at 100cm, it also did not provide a cooling effect because the sitting position (cooking activities) occur at the height of 50-70cm based on furnace.

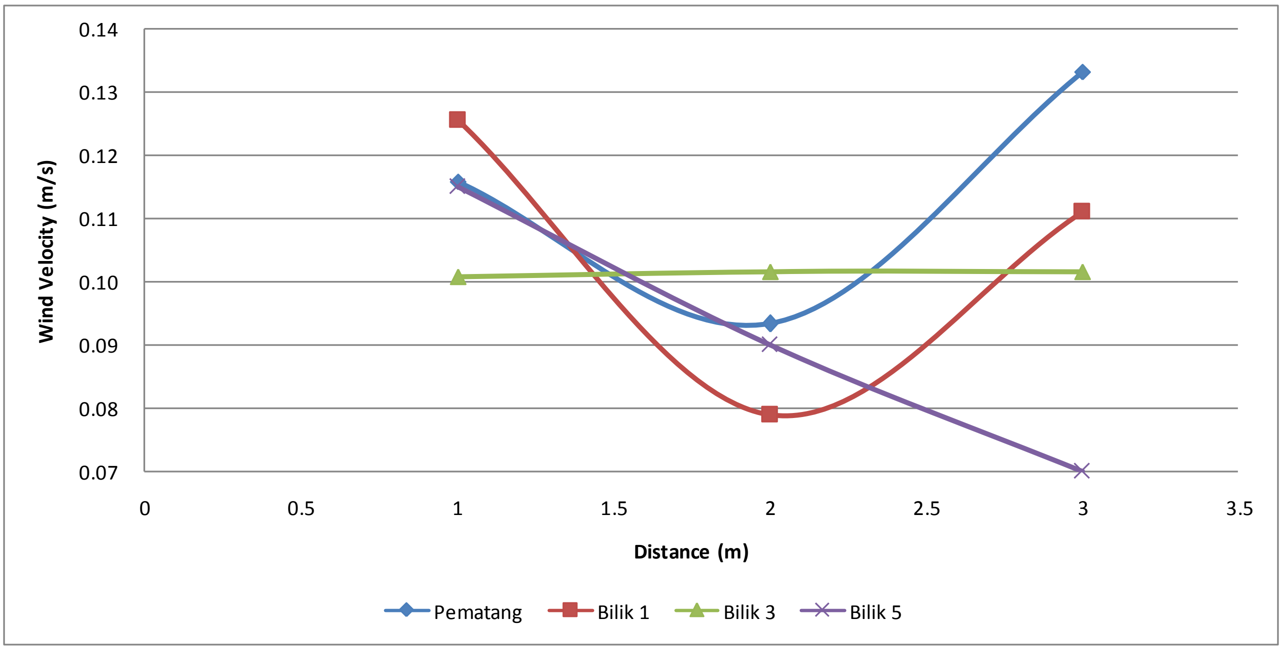

Fig. 5 Wind Velocity value in Balai Padang, due to different WWR, position and placement of opening

In *Bilik 3*, which only used as a bedroom, the room does not have a kitchen. As shown on Table 3, opening height from the floor is 180 cm, this position is not favorable for the cooling conditions. In *Bilik* 5, the opening position either in the bedroom or in the kitchen, are above the resident's activity position and make residents feel uncomfortable.

In terms of function, it is used for the annual ceremony filled with ritual dances in a sitting and standing position. Openings positions are 170cm from the floor , so when on sitting position the airflow do not meet the human body directly.

Based on those explanation, the height of the openings position that exist in each area was not suitable for attempt on occupant's physiological cooling.

The influence of placement opening on indoor wind velocity

Placement of the openings affect the performance of maximum wind. Horizontal openings or square inlet opening works better than vertical opening (Givoni, 1998). Horizontal shaped inlet provides optimal performance when the incidence angle of wind directed at a position about 45° (Busato, 2003).

The shape and configuration of openings in a traditional house in Balai Padang generally arranged horizontally across the room and triangular in shape due to the shape of the existing roof. In *Bilik* 1 and 2, the configuration of openings are arranged horizontally at each intersection of triangular shaped roofs and walls. There are also square shaped openings in the middle of the kitchen wall.

In *Bilik* 3 and 4, they have the same configuration of openings, the triangle-shaped openings of the roof and walls, and rectangular-shaped openings along the walls of the room. The same was found in *Bilik* 5 and 6. While on *Pematang*, the openings are arranged horizontally surrounding the room. The configuration and shape variation of the openings affect the airflow through it, causing difference in the acquisition of the wind velocity in each space. Those condition also influenced by wind direction that reach the opening.

As seen in figure 5 airflow in *Bilik* 1, 3 and *Pematang* have the same pattern. Airflow pattern from the inlet have a high starting point, then decrease to a lower value in the middle of the room, then increase again near the outlet just slightly lower than the inlet. It was caused by smaller size of the inlet than the outlet. Despite of the same opening size in every *bilik*, *Bilik* 3 have different pattern of airflow velocity value. *Bilik* 3 have steady pattern of airflow velocity because of the opening position and room layout that different than other *bilik*. On the contrary, *Bilik* 5 have decrease pattern of airflow velocity because of the larger size of the inlet than the outlet, despite of the same room layout and opening position of the room.

CONCLUSION

Airflow velocity value in the building is relatively low and it can not afford occupant's physiological cooling. Based on field observation and measurement, the low airflow velocity happen because of these reasons:

- the lack of the opening (WWR < 20%)
- the opening position that much higher than occupant activity area (170cm from the floor)
- most of the opening facing West and East, same as the dominant windward direction, but the wind can not reach the openings on its full velocity due to narrow distance between buildings.

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